TACOMA POWER
TACOMA PUBLIC UTILITIES

# Customer Requirements
# Conduit Installations, High Voltage

**C-UG-1100**

## Application

Requirements for high voltage underground conduit systems, installed by customer or contractor, which will be owned and maintained by Tacoma Power. High voltage underground conduit installations shall be governed by this standard and any supplemental Tacoma Power specifications.

## In This Standard

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## General

- All cable/underground conductor shall be installed within conduit per this standard. Cable/underground conductor shall not be direct buried.
- All materials and equipment required for the construction of the conduit system shall be furnished by the customer/contractor, unless specifically stated otherwise in the special conditions of the Letter of Agreement or Tacoma Power Construction Contract Specification.
- According to the Tacoma Power Customer Service Policies, all conduit will revert to Tacoma Power's ownership after construction has been completed, inspected, and approved by the Tacoma Power Construction Inspector.
- Permanent structures are never to be constructed or moved on top of buried Tacoma Power conduit or cable.

## Inspection

- The customer/contractor shall contact the appropriate Tacoma Power Inspector at least 24 hours in advance of beginning construction.
- Construction work performed without prior notice to the Inspector will be subject to rejection.
- Materials or workmanship failing to meet the requirements of this standard will be rejected. Damaged or unacceptable materials shall not be used in the work.
- Materials delivered to the job site shall be subject to inspection by the Inspector.
- If required by the Tacoma Power Inspector, the customer/contractor must remove the rejected material and furnish and install, at customer/contractor expense, approved material and/or workmanship.
- No work shall be embedded in concrete, backfilled, or covered or concealed until it has been inspected and approved by the Tacoma Power Inspector.

## Separation from Other Utilities and Structures

- Separation from Tacoma Power conduits and other utilities is detailed in NESC 320.B, “Separation From Other Underground Installations”.
- Typical separation is a minimum of ***12 inches of earth***, but lesser distances may be used where the parties agree.
- Conduit shall be installed a minimum of 3 feet from any structure.

## Type of Conduit

The type of conduit for each application shall be determined by the Tacoma Power Engineer. The standard acceptable type of conduit is shown below:

| Conduit Type | Requirements |
|---|---|
| **PVC** | • Sch. 40 or Sch. 80<br>• Must conform to UL 651 and NEMA TC-2<br>• Color: Gray |

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## Conduit Applications

Conduits and encasement provide various ***levels of protection*** for cables. This table lists the different levels and typical applications. The Tacoma Power Engineer will specify which level(s) will be required.

| Installation | Typical Application |
|---|---|
| **Sch. 40 PVC** | Standard for installation in a trench and Horizontal Directional Drilling (HDD) (See "Horizontal Directional Drilling" on page 9). |
| **Sch. 80 PVC** | For areas where minimum cover is not possible and/or for heavy duty applications. |
| **Sch. 40 PVC Encased in CDF or FTB** | Controlled Density Fill (CDF) encasement provides some added protection, and is used:<br>• For instant compaction when installation time is a factor.<br>• Local permitting jurisdiction, or third party, requires it.<br>• Under foundations as required.<br>Flowable thermal backfill (FTB) offers an increase in cable ampacity; see standard C-UG-2050 "Customer Requirements, Thermal Backfill for UG Power Cable Installations". |
| **Sch. 40 PVC Encased in Concrete** | Rarely used any more, only special conditions such as:<br>• Where a geotechnical analysis requires it, for example very heavy traffic in poor soils.<br>• Local permitting jurisdiction, or third party, requires it. |
| **Warning Ribbon** | Warning ribbon is installed 6" to 12" below final grade in those locations where minimum cover is not possible. |
| **Red Dye Encasement** | If local permitting jurisdiction, or third party, requires it. |

## Conduit Components

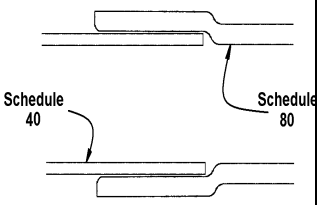
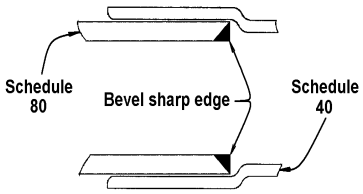
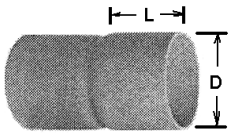
### Elbows

- All elbows shall be made to comply with ANSI Standard C80.1-83 and/or ASTM Standards F512, as appropriate.
- Elbow saddle blocks may be required on some bends depending on soils and pulling tensions.
- The minimum radius of elbow used in all conduit installations, unless otherwise specified by the Tacoma Power Engineer, shall be:

| Conduit Trade Size | 2.5" | 4" | 5" | 6" |
|---|---|---|---|---|
| **Minimum Radius** | 36" | 36" | 48" | 48" |

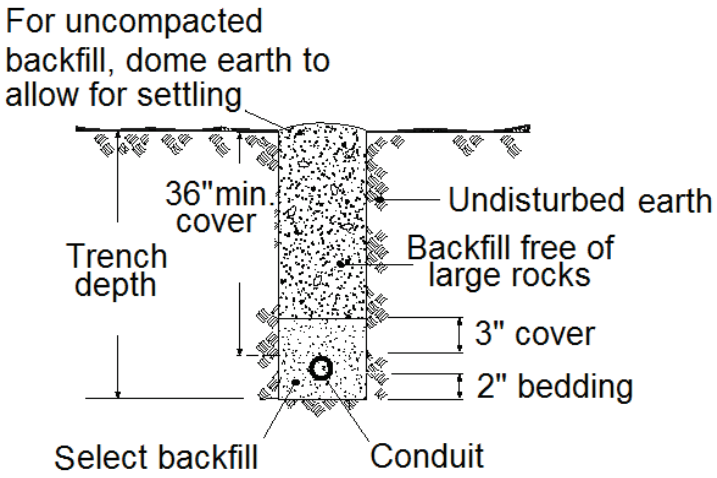
## Conduit Components *(continued)*

**Pole Riser Transitions** The most common examples of conduit type transitions are at pole risers.

| | | |
|---|---|---|
| **Sch. 40 PVC to Sch. 80 PVC** |  Preferred transition with Sch. 80 bell end. |  Alternate transition with Sch. 40 bell end, the sharp edge on the Sch. 80 end must be beveled or filed down. |
| **Couplings** |  | Deep socket couplings are required, where ***the socket depth (L) equals the conduit diameter (D)***. |

## Trenches for Conduit

**Figure A** Typical Trench



## Trenches for Conduit *(continued)*

**General**

- The trench shall be straight from point to point.
- The bottom of all trenches shall be flat, smooth, uniform, and free of any and all rocks exceeding ***2 inches***, obstructions, sharp objects, buried timbers and pilings, and other debris encountered.
- Water in the trench shall be removed by pumping or draining as necessary.

**Cover over Conduit**

- The minimum cover over conduit shall be ***36 inches***, or the requirement of the local permitting jurisdiction, whichever is greater.
- Total cover is measured vertically from the final grade to the top of the conduit.
- At Tacoma Power Engineer's direction, the burial depth may be more or less than the standard 36 inch depth in order to accommodate installation.
- The customer/contractor is responsible for determining finished grades to assure that minimum burial depth requirements are met ***after*** conduit installation.

**Sloping & Shoring**

Trenches shall be prepared according to WAC 296-155 Part N, “Excavation, Trenching, and Shoring”.

**Bedding and Cover**

Select backfill includes the 2 inches of ***bedding*** and 3 inches of ***cover*** as shown in Figure A.

- No construction debris shall be left in the trench.
- Select backfill material shall be free of rocks exceeding ***2 inches***, obstructions, sharp objects that could cut the conduit, or any materials that will create pressure points that would crush the conduits during or after the bedding and backfill process.
- If the excavated material is found to be unsuitable for select backfill as determined by the Tacoma Power Inspector, the unsuitable material shall be hauled away and disposed of, and sand or Class B bank run gravel with 100% passing 2 inch screen shall be brought in.
- The select backfill shall be compacted evenly on both sides of the conduit to fill all voids, and shall be placed to prevent damage to the conduit.
- For un-compacted backfill, dome the top of the trench to allow for settlement.

**Compaction**

- Where compaction is required, backfill shall be mechanically tamped to 95% compaction in 6 inch lifts, or to the requirements of the local permitting jurisdiction whichever is greater.

**Caution!**

- Backhoe compactors (hoe-pacs) can generate tremendous forces, and should be used only for final compaction. ***Do not use within 30 inches of conduits*** to avoid damage.

**Restoration and Cleanup**

It shall be customer/contractor responsibility to restore all areas disturbed by construction back to a condition equal to or better than that which existed before construction.

## Trenches for Conduit *(continued)*

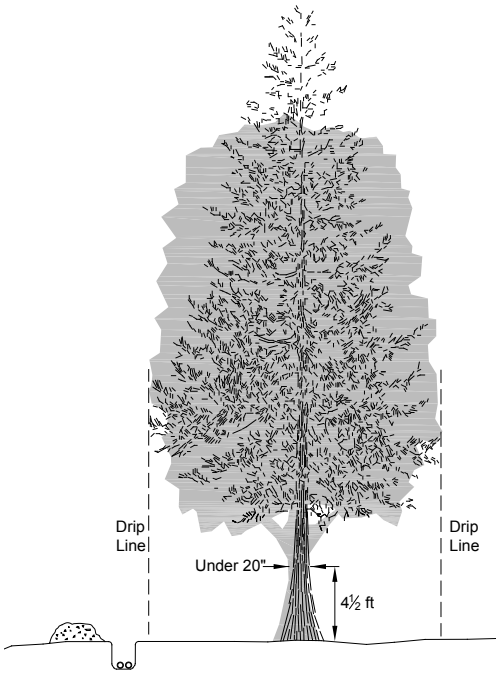
**Trenching Near Trees**

**What to do**

Where trenching work will be conducted near trees, the trees should be removed. If this is not possible, follow these practices:

**Small Species Trees** (as determined by Tacoma Power Arborist) and/or for mature trees measuring *less than 20 inches* in diameter at 4.5 feet above grade.

- When space allows, trenching will be routed outside the drip line of existing tree(s).
- When tree roots 2 inches in diameter, or larger, are accidentally or unavoidably cut, they will be sawed flush on the tree side of the trench.
- Whenever possible, soil from a trench will be piled on the side of the trench farthest from the tree(s).



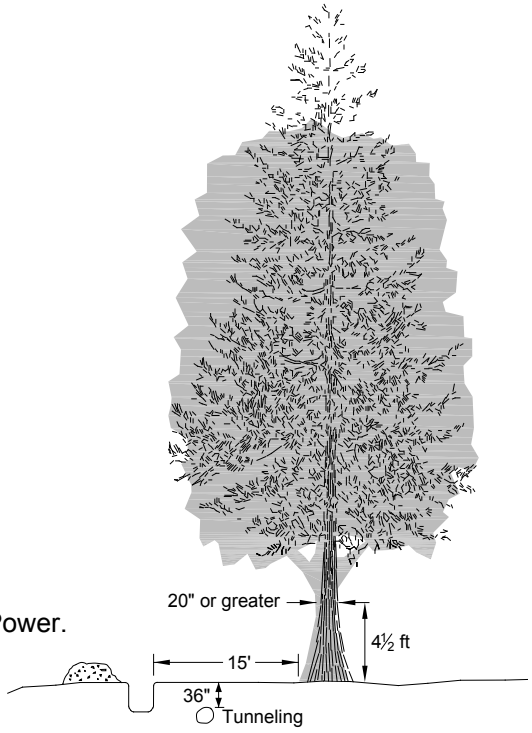

- Trenches will be back filled in a timely manner and compacted to no more than their original firmness when possible.
- Backfill will be kept clean of trash, chemicals or any other waste or debris.

## Trenches for Conduit *(continued)*

**Trenching Near Trees** *(continued)*

**Large Species Trees** (as determined by Tacoma Power Arborist) and/or for mature trees measuring *20 inches* or greater in diameter at 4.5 feet above grade.

- Tunneling under the tree roots at a depth of at least ***36 inches*** below grade is the preferred method when possible.
- If tunneling is not possible, maintain a minimum distance of ***15 feet*** from the trunk of the tree to the trench.




**For more information**
Contact a ***Certified Arborist*** at Tacoma Power.

## Conduit Encased in Concrete, CDF or FTB

**Installed**

- The conduits shall have a maximum cover of 3 inches in every direction. Anything higher becomes an underground wall for water or other utilities. There may be exceptions where underground obstructions require a higher limit.
- Where conduit transitions above-grade, the elbow shall be Sch. 80 PVC (or Steel if required by the local permitting jurisdiction).

**Spacers and Hold Downs**

- Conduit spacers shall be used in ***all encased conduit applications***.
- Conduits and spacer assemblies are to be firmly secured and tied down. Hold down methods shall be used to control floating of conduits during the encasement process.
- The backfill material installed in trenches containing conduit spacers shall not contain rocks that exceed the edge-to-edge separation distance between conduits.
- The minimum space between conduits shall be ***2 inches***.
- Concrete is to be hand-worked to completely fill all voids between conduits and earth or forms.

## Conduit Encased in Concrete, CDF or FTB *(continued)*

**Concrete Specification**

Concrete for conduit encasement shall be Class "B" (3,000 psi at 28 days- 5 ¾ sack), as specified in Section 6-02.3(2) of the latest revision to the State of Washington Standard Specifications for Road, Bridge, and Municipal Construction. Surfaces upon which concrete is to be placed shall be free of standing water, mud, and debris. Absorptive surfaces against concrete to be placed shall be moistened.

**Cold Joint Construction**

When it is necessary to make cold joints in the concrete encasement, they shall be made on a uniformly sloping plane at the angle of repose of the fresh concrete and shall be roughened. Before beginning the next pour, the surface of previously placed concrete shall be thoroughly cleaned.

**Concrete Reinforcing**

- Systems of ***up to 6 conduits*** shall be reinforced with a minimum of two No. 4 reinforcing bars placed in the bottom of the conduit line.
- All reinforcing bars shall have a minimum concrete cover of 3 inches on the bottom and 2 inches on the sides.
- Special conditions such as extremely heavy wheel loads in soft soils, or conduit lines composed of **more than 6 conduits**, will necessitate special reinforcing requirements detailed by the Tacoma Power Engineer.
- Reinforcing steel shall be in accordance with the latest revision to the State of Washington Standard Specifications for Road, Bridge, and Municipal Construction, except that reinforcing steel shall conform to the requirements of ASTM Designation A-615, Billet Steel Bars for Concrete Reinforcement, including supplementary requirements 51, Grade 40.

**Controlled Density Fill (CDF) Specification**

- CDF mix shall consist of Portland cement, water, fine aggregate and, if required by the engineer, accelerating admixtures. The proportions of the CDF shall conform to a mix design that shall be submitted with test results to the engineer for approval.
- CDF shall have a 28 day unconfined compressive strength from a minimum of 50 psi to a maximum of 150 psi and have a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place. CDF shall have a slump, as tested by ASTM C 33, of not more than 10 inches.
- Fine aggregate shall be sand meeting the requirements of the State of Washington Standard Specifications for Road and Bridge Construction, "Fine Aggregate for Portland Cement Concrete", 9.03.1(2).

**Flowable Thermal Backfill (FTB) Specification**

For FTB requirements, see standard C-UG-2050 "Customer Requirements, Thermal Backfill for UG Power Cable Installations".

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## Conduit Installation

**General**

- All conduits shall be installed in accordance with the manufacturer's recommendations. This includes adequate glue and seating ends into couplings or bell ends to their full depth.
- Curves in an otherwise straight conduit run must be approved by Tacoma Power.
- Conduits shall be placed so that they are on firm bearing for the length of the installation and shall be laid on as uniform a slope as possible.
- Provide adequate support on each side of conduit when conduit crosses over another utility, to prevent load transference onto other utilities.

**Into Vaults**

All conduits entering a vault shall follow the requirements of the following standards:

| Vault Type | See Customer Requirements Standard… |
|---|---|
| Junction Box | C-UG-1500, Primary Junction Box Installation |
| Transformer Vault | C-UG-1700, Transformer Vault Installation |
| Precast Concrete SSB | C-SV-3200, Commercial Secondary Service |

## Horizontal Directional Drilling (HDD)

Tacoma Power requires Sch. 40 PVC, locking joint type conduit systems for HDD applications. HDPE conduit is not allowed.

The following are approved manufacturers for HDD conduit:

- Certa-Com by North American Pipe Corporation
- Can-Loc by Cantex
- Bore-Gard by Prime Conduit

## Prove the Conduit

- After conduit installation is complete and final grade is established, the customer/contractor will be required to prove conduit integrity using a Tacoma Power approved mandrel and with the Tacoma Power Inspector present.
- After swabbing the conduits clean and proving that the conduits are free from debris and obstructions, the customer/contractor shall leave a silicone-coated nylon pull tape, or Tacoma Power approved equivalent, marked in feet and secured at both ends of each conduit.

## References

- National Electric Safety Code (NESC), Section 32, Underground Conduit Systems
- “Trenching and Tunneling Near Trees: A Field Guide for Qualified Utility Workers” by Dr. James R. Fazio